

XXIV.—*On the Investigation of Microscopic Forms by means of the Images which they furnish of External Objects; with some Practical Applications.* By Prof. O. N. ROOD, of Troy, N.Y.*

It would hardly occur to a physicist, who was requested to determine whether a certain disk of glass was a convex or a concave lens of slight curvature, to attempt a solution of the question by glancing along the two sides; on the other hand, neglecting even to look at the glass, he would at once bestow his undivided attention upon the *images* of external objects formed by it, and thus with ease and certainty decide upon the nature, degree, and regularity of its curvature.

The simple idea here enunciated seems hardly to have been applied to the study of microscopic forms, though, from some experiments lately made in this direction, I am firmly convinced that this method of determination is destined hereafter to play a most important part in microscopical observation. To the microscopist it will prove as powerful a means of investigation as it now is in the hands of the optician.

The most convenient and effective mode of proceeding in this case which has occurred to me is the following:—The microscope is brought into a horizontal position, the mirror removed, and the illumination supplied by a candle or lamp placed in the axis of the compound body at a distance of not more than three inches from the stage. If now a small sphere of glass be properly supported on the stage, it forms behind itself a very minute inverted image of the flame of the candle; upon drawing back the compound body slightly, this image comes into focus, and is seen of course in an erect position. When a rod of $\frac{1}{10}$ th of an inch in thickness is moved up and down between the flame and the globe, an image of it is seen in the microscope with great distinctness, and it is observed that the motion of this image follows in all respects the motion of the hand. Upon replacing the sphere by a minute concave lens, as an air-bubble in water, the reverse takes place; to gain distinct vision of the flame, it becomes necessary to move the compound body within the focus; the image of the flame is seen to be inverted, and, what is practically more important, the motion of the rod seems reversed. It will happen very generally, in applying this method, that the image of the flame is not sufficiently perfect to decide whether it is erect or inverted; the *motion of the rod* then furnishes us with a certain means of deciding this point: if its motion is natural, the image is erect, and the curvature convex, &c. After some practice, it becomes easy to obtain the best focal adjustment for distinct vision of the rod, and in extreme cases where the image is very

* From Silliman's 'American Journal of Science,' &c., Jan. 1862.

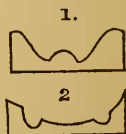
badly defined, the focal adjustment is best made while the rod is in gentle motion. I now adduce one or two applications of this method.

Examination of the nature of the Markings on the Coscinodiscus, Triceratium, &c.

It is well known among microscopists that the controversy regarding the nature of the marking on these shells, after being carried on for several years with spirit, cannot even yet be considered as settled,—one party contending that the areolæ are depressions, while their antagonists see them as elevations. Compare Carpenter 'On the Microscope,' page 280, American edition.

Fine specimens of these shells mounted in water were examined by a power of from 600 to 800 diameters; on moving the compound body within the focus, each hexagon was found to contain a small distinct image of the flame; the motion of the rod showed that the images were inverted, and consequently formed by *concave lenses*. As the index of the refraction of water is much less than that of silica, its effect is merely to diminish the action of the curved surfaces, but in no case to reverse it. These shells were now mounted in Canada balsam and observed. As the index of refraction of the balsam is somewhat greater than that of silica, it was to be expected that in the compound lenses of silica and balsam the latter would predominate, and reverse the action, so as to present effects due to convex lenses. This was found to be the case, and in some of the valves the eye could readily follow, in a hundred areolæ at a time, each flickering motion of the flame as it was stirred by the wind. The valves, when mounted in balsam of tolu, which has a still higher index of refraction, gave like results. These experiments, which are not difficult to repeat, prove that the areolæ are well-formed *concave lenses*.

A similar mode of experimenting, which must be conducted on large valves, and with some delicacy, shows that the border or setting, so to speak, has the opposite curvature, viz. is convex; whether it is convex as a cylinder, or beset with several convex markings, I have not had leisure to determine, though in some large specimens the latter seemed to be the case. Indications also were observed in some large specimens that would lead to the deduction of a form optically equivalent to that seen in fig. 1; and certain allied forms readily furnished the curve seen in fig. 2, the small depressions being pits.



This mode of experimenting often furnishes us the means of determining whether certain appearances are really due to open-

ings or to some other cause. Thus the small circles at the middle and ends of the *Pinnularia viridis* have been mistaken by some eminent observers for openings. Prof. Bailey proved, by the action of hydrofluoric acid, that they are in reality thicker portions of the shell; and examination by the method here described shows that they are convex lenses, giving often very well-defined images of the flame. The dots characterizing the *Coniferae* furnish images of the flame indicating two or more curvatures; the ribs of the *Pinnularia* and the spaces between them have opposite curvatures, &c. But the examples already given may be sufficient to show the usefulness of the proposed method.

Index of Refraction of the Silica composing the Valves of the Diatoms.

This point is closely connected with the foregoing; and it may not be amiss to detail a few experiments that were made to determine it.

Although Canada balsam has the same index of refraction as quartz, still the valves of the Diatoms which are composed of silica are seen almost as distinctly in balsam as when mounted in water.

To ascertain the relation between the index of refraction of quartz and Canada balsam independently of optical tables or laborious experiment, I combined a convex quartz lens, of one-inch focus, cut at right angles to the optic axis, with unheated fluid balsam placed on a glass slide; the two opposite refractions balanced each other so perfectly, that the combination acted like a plate of glass with plane parallel sides, and, with ordinary means, I was at a loss to discover any tendency to convexity or concavity. Balsam which had been heated was now combined with the quartz lens in the same manner: the balsam proved to have gained in refractive power, so that the combination now acted distinctly as a concave lens of weak curvature.

Diatoms were then mounted in this unheated fluid balsam, in which properly they should have been invisible, owing to the coincidence of refractive indices; but, as had been anticipated, they appeared beautifully, though perversely, distinct. A casual remark from Alex. S. Johnson, Esq., concerning a certain chemical difference he had often noticed between ordinary silicea and that composing the Diatom-valve, again turned my attention to this point. Experiments were made upon a sample of the Rappahannock infusorial earth, which had been given to me by Prof. Wm. B. Rogers, in its natural state. By immersing the valves in various liquids, I finally ascertained that in strong sulphuric acid they became either *invisible* or very nearly so, while the grains of sand on the slide retained their distinctness

perfectly. It was curious to observe how, by diluting the acid with water, the valves again became visible and distinct in outline markings. By igniting this earth I produced a slight change in the index of refraction of the silica composing the valves, so that afterwards they were visible with tolerable distinctness in the same sample of sulphuric acid.

Index of refraction of water	1.336
” ” sulphuric acid	1.435
” ” Diatoms	1.435
” ” quartz	1.548
” ” Canada balsam	1.548

This table shows that the index of refraction of the Diatoms is about half-way between that of water and Canada balsam, thus explaining the fact that they appear about equally distinct in both of these media.

XXV.—On *Ætotoxicum* and *Bursinopetalum*.

By JOHN MIERS, F.R.S., F.L.S. &c.

ÆTOTOXICUM.

THE position of this genus of the Flora Peruviana has not yet been satisfactorily established; but the observations I have been enabled to make will probably throw some light on the subject. The only botanist who has suggested a place for it is Sir Wm. Hooker, who, in 1837, referred it to *Euphorbiaceæ*; but the structure of the fruit and seed, with other characters, militate against this conclusion. Notwithstanding the anomaly of some of its features, the weight of the evidence here collected together will, I think, show its close proximity to the *Aquifoliaceæ*. The distinguished botanist just mentioned, when he described its flowers as being diœcious, had only seen the male plant; they are, however, properly speaking, polygamo-diœcious: that is to say, in the male flowers the ovary, though present, is rudimentary and sterile; and in the female flower, although the stamens of the usual size exist, the anther-cells are abortive and deficient of pollen: the two sexes are always in distinct plants, and in all these respects the genus resembles *Prinos* and *Nemopanthes*: so far, therefore, *Ætotoxicum* is quite reconcileable with the *Aquifoliaceæ*. Its only known species is a native of the central and southern provinces of Chile, where it forms an evergreen tree of some height, with oblong alternate leaves, covered with lepidote scales. Its flowers are small, in simple axillary racemes much shorter than the leaves, the whole inflorescence being densely covered with lepidote scales similar to those of the leaves. Each flower, while in bud, is closely invested by a membrana-